

CRITERION 101
O&M CRITERION WRITER'S GUIDE

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RECORD OF REVISIONS

Revision No.	Date	Description
0	08/27/98	Initial Issue
1	03/01/00	This revision reflects the conversion from a WordPerfect document into a Microsoft Word document and additional clarification of how to develop criteria.
2	03/06/01	This revision includes <ul style="list-style-type: none">• The addition of a Table of Contents,• The use of Basis Statements in Sections 6, 7, and 9,• References to “Lessons Learned” in Section 6, “Requirements,”• Revision to Section 9, “Required Documents,” and• Further clarification in the use of references.
3	01/09/02	Incorporation of comment and rewording requested by the Maintenance Subcommittee.
	04/03/02	Changes to Section 4.0 to address O& M Criterion written by groups other than FWO-SEM
	07/12/02	Editorial Change to Section 4.3.2

CRITERION 101**O&M CRITERION WRITER'S GUIDE**

This document is designed to provide a standard document format and style guide for use in developing the Operations and Maintenance (O&M) Criterion for structures, systems, and components (SSCs) as required by LIR 230-05-01, "Operations and Maintenance Manual." (Ref. 10.1) The format and examples of the type of technical content that shall be adhered to by all organizations in the development of assigned Criterion is defined below.

Guidance on how to develop each section of the Criterion is provided in *Italics*. Examples are provided within each section after the guidance. Examples appear just as they would in an actual Criterion (i.e., font, paragraph numbering, style, etc.).

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Revision numbering begins with 0a and then proceeds through the alphabet (e.g., 0b, 0c, etc.) for each internal revision.

RECORD OF REVISIONS

Under "Description" include range of dates for Lessons Learned. For additional revisions, include pertinent information describing why the document was revised.

Example

Revision No.	Date	Description
0	03/07/00	Initial Issue – Incorporates a review of ORPS & NRC lessons learned from 1/1/95 to 2/1/2000.
1	11/14/00	Added requirement 7.2.4 and reviewed Lessons Learned from 2/00 to 10/00 for additional relevant information.

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Placing your cursor in the shaded area below and pressing the F9 key after you have completed your document automatically generates the Table of Contents. You will be prompted to update the page numbers only or update the entire table of contents. You should select “update page numbers only.” Note that the Table of Contents is only necessary to Level 2 of the document. If you prefer, the technical editor can generate your table of contents.

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Figures

A list of figures shall be generated if there are three or more figures in the document. The technical editor will generate a list of figures if needed. When generating figures in a document, number them sequentially within a section (e.g., Figure 6-1, Figure 6-2, etc. for figures in Section 6) and place the titles at the bottom of the figure.

Example

Figures

Figure 8-1, Effect of Voltage Variation on Induction Motor Performance Characteristics. 18

Tables

A list of tables shall be generated if there are three or more tables in the document. The technical editor will generate a list of tables if needed. When generating tables in a document, number them sequentially within a section (e.g., Table 6-1, Table 6-2, etc. for tables in Section 6), and place the title at the top of the table.

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This page shall be deleted if figures and tables are not needed.

CRITERION XXX**TITLE****1.0 PURPOSE**

In this section clearly and concisely state the purpose of the criteria and why it has been issued. Additional information to clarify any special aspects regarding the specific need for the document and its implementation at LANL may be included.

In all cases, include the following statement:

This document addresses the requirements of LIR 230-05-01(Ref 10.1), "Operations and Maintenance Manual."

Implementation of this Criterion satisfies DOE Order 430.1A (Ref 10.2) for the subject equipment / system. DOE Order 430.1A (Ref 10.2) "Life Cycle Asset Management," Attachment 2 "Contractor Requirements Document," Paragraph 2, Sections A through C, which in part requires UC to "...maintain physical assets in a condition suitable for their intended purpose," and employ "preventive, predictive, and corrective maintenance to ensure physical asset availability for planned use and/or proper disposition." Compliance with DOE Order 430.1A is required by Appendix G of the UC Contract.

Example

The purpose of this Criterion is to establish the minimum requirements and best practices for operation and maintenance of Electrical Motors ranging from 5 Hp. to 200 Hp. at LANL.

This document addresses the requirements of LIR 230-05-01(Ref 10.1), "Operations and Maintenance Manual."

Implementation of this Criterion satisfies DOE Order 430.1A (Ref 10.2) for the subject equipment / system. DOE Order 430.1A (Ref 10.2) "Life Cycle Asset Management," Attachment 2 "Contractor Requirements Document," Paragraph 2, Sections A through C, which in part requires UC to "...maintain physical assets in a condition suitable for their intended purpose," and employ "preventive, predictive, and corrective maintenance to ensure physical asset availability for planned use and/or proper disposition." Compliance with DOE Order 430.1A is required by Appendix G of the UC Contract.

2.0 SCOPE

In this section, provide a concise description of the types of activities, facilities, systems, or equipment to which the document applies. Where applicable, state in this section what size and

type of equipment, facility, and applicability to Institutional and/or Programmatic SSCs are within the scope of this Criterion. To ensure clarity, the author may also specify SSCs that fall outside the scope of this Criterion.

In short, the author must set the boundaries of the document. To do this, review related criterion scope sections to determine if they cover parts of a system that could fall under the criterion currently being developed. For example, filters, motors, and refrigeration systems do not need to be covered in the Air Handling System criterion; however, it is helpful to refer the reader to them. When in doubt as to where something is to be covered contact the FWO-SEM criterion project manager or the FWO-SEM group leader for clarification.

Example

The scope of this Criterion includes the routine inspection, testing and preventive and predictive maintenance of Electrical Motors with horsepower ratings from 2 Hp to 200 Hp, single phase and three-phase power source, all frame types, at all nuclear and non-nuclear LANL facilities. Lubrication is not addressed; see Criterion 427, Lubrication. This Criterion does not address corrective maintenance actions required to repair or replace equipment.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

In this section, alphabetically list all acronyms used in the body of the Criterion.

Example

AR	Administrative Requirements
CFR	Code of Federal Regulations
LIG	Laboratory Implementing Guidance
LIR	Laboratory Implementing Requirement
LPR	Laboratory Performance Requirements
LPS	Lightning Protection System
O&M	Operations and Maintenance
PPE	Personal Protective Equipment
PP&PE	Personal Property and Programmatic Equipment
RP&IE	Real Property and Installed Equipment
SSC	Structures, Systems, and Components
UC	University of California

3.2 Definitions

In this section, in alphabetical order, define any terms that are used in the criterion that may not be obvious to the reader or are subject to interpretation. For terms that are not unique to the Criterion, but need to be restated, reference the original source of definitions in detail.

Example:

Air Terminal. A strike termination device that is essentially a point receptor for attachment of flashes to the lightning protection system and is listed for the purpose. Typical air terminals are formed of a tube or solid rod. Air terminals are some times called lightning rods. Definition per NFPA 780. (Ref. 10.6)

Insulation Resistance Test (meggering). A test for measuring the electrical resistance between two conductors separated by an insulating material. (McGraw-Hill Dictionary of Scientific and Technical Terms 5th Edition).

Personal Property and Programmatic Equipment (PP&PE). Equipment used purely for programmatic purposes, such as reactors, accelerator machinery, chemical processing lines, lasers, computers, machine tools, etc., and the support equipment dedicated to the programmatic purpose. This property/equipment is also referred to as organizational, research, production, operating or process and was formerly known as Class B. Definition per DOE Order 4330.4B. (Ref. 10.3)

Polarization Index. The polarization index is a specialized application of the insulation resistance test. The index is the ratio of insulation resistance at two different times after voltage application, usually the insulation resistance at 10 minutes to the insulation resistance at 1 minute. (NFPA 70B, Section 18-9.2.3)

Real Property and Installed Equipment (RP&IE). The land, improvements on the land such as buildings, roads, fences, bridges, and utility systems and the equipment installed as part of the basic building construction that is essential to normal functioning of a building space, such as plumbing, electrical and mechanical systems. This property/equipment is also referred to as institutional or plant and was formerly known as Class A. Definition per DOE Order 4330.4B.

4.0 RESPONSIBILITIES

In this section, clearly define the responsibilities associated with implementing and maintaining the subject Criterion alphabetically. Include responsibilities for FWO-SEM, SME organization (if different from FWO-SEM), the Facility Manager, Group Leaders, and others as applicable.

When FWO-SEM is author or SME, include the following statement of responsibilities for FWO-SEM:

*FWO-SEM is responsible for the **technical** content of this Criterion and monitoring the applicability and the implementation status of this Criteria and either assisting the organizations that are not applying or meeting the implementation expectations contained herein or elevating their concerns to the director(s).*

*Basis: LIR 301-00-01.11 ; Issuing and Managing Laboratory Operations
Implementation Requirements and Guidance, Section 5.4, OIC
Implementation Requirements.*

FWO-SEM shall provide technical assistance to support implementation of this Criterion.

Criteria authored by organizations other than FWO-SEM shall include the following statement of responsibility for FWO-SEM:

*FWO-SEM is responsible for the **administrative** content of this Criterion and monitoring the applicability and the implementation status of this Criteria and either assisting the organizations that are not applying or meeting the implementation expectations contained herein or elevating their concerns to the director(s).*

*Basis: LIR 301-00-01.11 ; Issuing and Managing Laboratory Operations
Implementation Requirements and Guidance, Section 5.4, OIC
Implementation Requirements.*

FWO-SEM shall provide technical assistance to support implementation of this Criterion.

Example:

4.1 FWO-Systems, Engineering and Maintenance (SEM)

4.1.1 FWO-SEM is responsible for the technical content of this Criterion and monitoring the applicability and the implementation status of this Criteria and either assisting the organizations that are not applying or meeting the implementation expectations contained herein or elevating their concerns to the director(s).

*Basis: LIR 301-00-01.11 ; Issuing and Managing Laboratory Operations
Implementation Requirements and Guidance, Section 5.4, OIC
Implementation Requirements.*

4.1.2 FWO-SEM shall provide technical assistance to support implementation of this Criterion.

4.2 Facility Manager

4.2.1 Responsible for operations and maintenance of institutional, or Real Property and Installed Equipment (RP&IE) under their jurisdiction, in accordance with the requirements of this document.

- 4.2.2** Responsible for operations and maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document that may be assigned to the FM in accordance with the FMU-specific Facility/Tenant Agreement.

4.3 Group Leader

- 4.3.1** Responsible for operations and maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document that are under their jurisdiction

- 4.3.2** Responsible for system performance and subsequent replacement or refurbishment of assigned PP&PE.

5.0 PRECAUTIONS AND LIMITATIONS

5.1 Precautions

In this section, list unique precautions needed to ensure the safety of personnel, the environment, or equipment unique to the Criterion being discussed. If an existing LANL document, (i.e., LPR, AR, LIR, or LIG), specifically addresses the hardware-related safety concerns (i.e., not general program information) for the process under discussion, also reference it in this section (refer the reader to it, do not restate its content).

It is important to note that the intent of this section is not to restate all applicable precautions (the existing LANL work control and safe work practice programs are intended to identify all applicable hazards). In this section only list those unique precautions that may not be obvious to the user.

In all cases, include the following statement:

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. A compilation of all applicable precautions shall be contained in the implementing procedure(s) or work control authorization documents. The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards and precautions that may not be immediately obvious.

Example

5.1 Precautions

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. A compilation of all applicable precautions shall be contained in the implementing procedure(s) or work control authorization documents.

The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards/precautions that may not be immediately obvious.

- 5.1.1 Personnel must be aware of a potential for electric motors with an automatic reset protector to automatically restart after motor cool-down. This could endanger personnel or equipment. Such applications should use a manual reset protector or an identification placard to caution personnel.
- 5.1.2 While re-lubricating motor bearings with grease and the drain plug is removed, under no circumstances should a mechanical probe be used while the motor is in operation.
- 5.1.3 Ensure electric motor units are electrically grounded and electrical installation wiring and controls are used consistent with NEC and NFPA electrical code requirements. (NEC Article 430 and 250)
- 5.1.4 When approaching rotating electro-mechanical parts, such as couplings, pulleys, shafts, external fans, and unused shaft extensions, personnel should guard against accidental contact with hands, tools, or clothing. This is particularly important where the parts have surface irregularities such as keys, keyways, or setscrews.
- 5.1.5 Do not lift a motor and its driven load by the motor lifting hardware. Motor lifting hardware is adequate for lifting of the motor only.

5.2 Limitations

In this section identify any unique limitations associated with this Criterion. Note that limitations in applicability should be placed in Section 2.0, Scope, not in this section.

In all cases, include the following paragraphs:

The intent of this Criterion is to identify the minimum generic requirements and recommendations for SSC operation and maintenance across the Laboratory. Each user is responsible for the identification and implementation of additional facility-specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, vendor O&M requirements and guidance, etc.).

Nuclear facilities and moderate to high-hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion. Nuclear facilities shall implement the requirements of DOE Order 4330.4B (Ref. 10.3) as the minimum programmatic requirements for a maintenance program. Additional requirements and recommendations for SSC operation and maintenance may be necessary to fully comply with the current DOE Order or CFR identified above.

Example:

5.2 LIMITATIONS

The intent of this Criterion is to identify the minimum generic requirements and recommendations for SSC operation and maintenance across the Laboratory. Each user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, vendor O&M requirements and guidance, etc.). Nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion. Nuclear facilities shall implement the requirements of DOE Order 4330.4B (Ref. 10.3) (or 10 CFR 830.340, Maintenance Management, when issued) as the minimum programmatic requirements for a maintenance program. Additional requirements and recommendations for SSC operation and maintenance may be necessary to fully comply with the current DOE Order or CFR identified above.

6.0 REQUIREMENTS

The purpose of this section is to clearly state what minimum requirements the Criterion users have to meet. In this section concisely state what minimum O&M related activities are required for the subject equipment/system. Required activities must be driven by either:

1. ***LIRs, ARs, Orders, codes, or standards committed to in the UC Contract.*** Perform a thorough search of applicable LIRs, ARs, and the DOE Orders, codes, and standards committed to in the UC Contract Appendix G to identify only those O&M requirements that the Laboratory must meet to satisfy the UC Contract. A search of these documents is required in the development of each Criterion. Each Criterion shall clearly define or describe the specific requirements for the equipment or process covered.
2. ***Formal commitments made to the DOE or other regulatory agencies.*** To the extent practical, identify and review any additional formal commitment made to the DOE or other regulatory agencies. These commitments may be found in various communications between various LANL organizations and DOE, EPA, the State of New Mexico, and others. Requirements that are adopted as a result of commitments made to the DOE, or other regulatory bodies, as a result of such items as inspections, audits, or accident investigations shall be listed.
3. ***Operating experience, the DOE/LANL Lessons Learned program, and/or engineering judgement.*** Operating experience, lessons learned, and engineering judgement should also be researched for additional requirements that the institution deems appropriate. As a minimum, Lessons-Learned reports shall be researched back 5 years from the date that the Criterion is being developed. Lessons-Learned data is available through the DOE Occurrence Reporting Program and its data system, the Occurrence Reporting and Processing Systems (ORPS) located at the following web address: <http://tis.eh.doe.gov/web/oeaf/orps/orps.html>. A copy of all ORPS reports researched by the Criterion author shall be provided in the project file (to be maintained by the O&M Criterion

Project Manager). Professional operating experience, engineering judgement, manufacturers recommendations and requirements, and system/equipment historical analysis form a basis for a requirement when the implementation of the requirement is proven to enhance safety, increase longevity of the SSC, insure availability for intended service or positively impact cost of maintenance and/or operations. The author must be capable of defending the requirement and the basis. Analysis results, a statement of the operating experience basis, and research documentation shall be provided in the project file.

In development of the Criterion, LIRs and ARs should be referred to but not restated. However, the requirements shall be restated when taken from DOE Orders, codes, standards, Lessons-Learned information, LANL communications, etc. that are not readily available to the user. Where this is not possible, a summary or paraphrase of the requirement shall be provided.

A “basis” statement shall be provided after each requirement listed. The basis statement shall clearly list the source document, where applicable (see LIR 230-05-01.0, Section 6.1 for other commitments), (including reference number, revision, section and/or page number) and if appropriate, the driver for the document. If the basis is the author’s judgement, manufacturer requirements, or operational experience, a justification shall be provided. In no case shall the phrase “engineering judgement” be used as a stand-alone basis, the author shall include (succinctly – less than one paragraph, preferably in a sentence or two) a defensible justification describing why the subject requirement is necessary. Bear in mind the contractual requirements to sustain the SSCs for intended and planned use when formulating the basis statements. Section 6.1 shall always be “Operations Requirements” and Section 6.2 shall always be “Maintenance Requirements.” When there are no requirements identified in a given subsection, simply state “No requirements beyond those stated in section 5.2, Limitations.”

In all cases, include the following statements immediately after the 6.0 Section heading:

Minimum requirements that Criterion users shall follow are specified in this section. Requested variances to these requirements shall be prepared and submitted to FWO-SEM in accordance with LIR 301-00-02 (Ref. 10.4), “Variances and Exceptions to Laboratory Operations Requirements,” for review and approval. The Criterion users are responsible for analysis of operational performance and SSC replacement or refurbishment based on this analysis. Laws, codes, contractual requirements, engineering judgement, safety matters, and operations and maintenance experience drive the requirements contained in this section.

Example

6.0 REQUIREMENTS

Minimum requirements that Criterion users shall follow are specified in this section. Requested variances to these requirements shall be prepared and submitted to FWO-SEM in accordance with LIR 301-00-02 (Ref. 10.4), “Variances and Exceptions to Laboratory Operations Requirements,” for review and approval. The Criterion users are responsible for analysis of operational performance and SSC replacement or

refurbishment based on this analysis. Laws, codes, contractual requirements, engineering judgement, safety matters, and operations and maintenance experience drive the requirements contained in this section.

6.1 Operations Requirements

In this section, list all operations-related requirements that shall be followed. Examples of potential requirements include special qualification/certifications requirements for operators. The author is strongly encouraged to grade requirements based on Management Level (ML) (Ref. LIG 230-01-02). The author may divide these requirements into subsections, as he / she deems appropriate.

Example

6.1 Operations Requirements

- 6.1.1** Inspect the floor area directly under the door and on the sides for tripping hazards that may create hazards to personnel. Inspect the areas affected by the operation of the door for obstructions that may interfere with normal operation of the door. These inspections should be performed every time the door is opened or closed.

NOTE: Documentation supporting execution of this requirement may be required for ML1 and ML2 door systems or as defined in a facility Authorization Basis. As a minimum, personnel that operate roll-up / overhead doors shall be able to demonstrate knowledge of this requirement.

Basis: These inspections are required to assure personnel safety and are based, in part, on DOE Lessons Learned ALO-LA-FIRNGHELAB-1995-0002 (Ref. 10.7). Wear of obsolete floor guides and other surrounding structures may become damaged and cause personnel injuries. Obstructions that may interfere with the normal operation of the door may cause personnel injury or damage to the door. This inspection should be performed every time the door is opened or closed.

- 6.1.2** Point-to-point testing of all zones of a Fire Alarm Control Panel shall be performed as post-maintenance verification of the operability of the system

Basis: NFPA 72-7-3.21(1) (Ref. 10.4). Compliance with NFPA code is required per Appendix G of the UC/DOE Contract.

- 6.1.3** Conduct routine inspections per the latest revision of LIR 307-01-03, "Management Safety Walk-Arounds." (Ref. 10.10)

Basis: Compliance with LIRs is required by clauses [5.14 (B)(1), and 6.7] of the DOE/UC contract.

6.2 Maintenance Requirements

In this section, list all maintenance-related requirements that shall be followed. Examples of potential requirements include the following:

- *Special qualification/certification requirements for personnel doing preventive maintenance activities.*
- *Preventive maintenance activities by frequency or type (including inspections, lubrications, routine part replacements, calibrations, functional tests, predictive maintenance, and surveillance's).*

The author is strongly encouraged to grade requirements based on Management Level (ML). The author may divide these requirements into subsections as he or she deems appropriate. These subsections can be organized by either maintenance frequency or equipment / component type, or any combination of the two. It is acceptable to organize this section to level 5 subsections, if necessary. When itemizing requirements, use an alphabetical list rather than a bulleted list. A basis statement shall be used for each numbered section and address any lettered lists within the section. Each item on a lettered list does not require a separate basis statement if the basis for all the elements on the list is the same. Basis statements can be combined to address several items on the list. The use of tables in this section is encouraged.

Example

6.2 Maintenance Requirements

6.2.1 Semi-Annual Intervals

6.2.1.1 Visually inspect critical welds between the curtain or panel support shaft and end-plates for damage or cracking.

Basis: This inspection is required to assure personnel safety and is based on DOE Lessons Learned ALO-LS-LANL-PHYSCOMPLX-1997-0003 (Ref. 10.8). Damaged welds can lead to failure and allow the door to fall uncontrollably. Several DOE locations have experienced near-miss accidents that could have been prevented by performing this inspection.

6.2.1.2 Inspect labels on the door control switches. Verify that the labels provide clear guidance for the operation of the door and cannot be confused with other equipment in close proximity to the operating door such as a dock leveler.

Basis: This inspection is required to ensure personnel safety and is based on Lessons Learned 1998-LA-LANL-ESH7-0009 (Ref. 10.5) and vendor instruction, e.g., Overhead Door Company; Recommended Preventive Maintenance - Rolling Doors 1994 (Ref. 10.3).

- 6.2.1.3** Freeze protection systems shall be inspected and verified to be fully operational and placed in service not later than 15 October of each year.

Basis: Operating experience at LANL has shown that early cold snaps are frequent and often result in significant facility and system damage as a result of inoperable freeze protection.

6.2.2 Annual Inspections

- 6.2.2.1** Perform the following visual inspections on the fire protection system:

- A. Inspect sealed lead acid batteries.
- B. Inspect control panel trouble signals.
- C. Inspect initiating devices, duct detectors, electro-mechanical releasing devices, fire extinguishing systems, fire alarm boxes (manual pull stations), and heat detectors.

Basis: NFPA 72-7-3.2(1) (Ref. 10.4). Compliance with this NFPA code is required per Appendix G of the UC contract.

6.2.2 Pre-Operational Inspections

- 6.2.2.2** Operators or equipment custodians must visually and functionally inspect their lifting devices before each shift. This inspection must be documented and should include items as listed on Form 1489 (ES&H Form 13-2D), Pre-operational Inspection Record for Overhead Cranes and Hoists.

Basis: AR 13-2, Cranes, Hoists, Lifting Devices, and Rigging (Ref. 10.6)
Note: AR 13-2 is to be included in LIR 402-1110-01.

6.2.3 Other

- 6.2.3.1** All unit emergency lighting fixtures shall be inspected at intervals not to exceed 30 days. The inspection shall include a functional test for a minimum of 30 seconds. Exception: Self testing unit emergency lighting equipment that automatically performs a minimum 30 second test and diagnostic routine at least once every 30 days and indicates failures by a status indicator shall be exempt from this test requirement.

Basis: ANSI/NFPA 101, subsection 31-1.3.7 (Ref. 10.9). Compliance with this NFPA code is required per Appendix G of the UC contract.

- 6.2.3.2** Check the sensitivity of each smoke detector within 1 year of installation and every 2 years thereafter in accordance with manufacturer's instructions. Use only manufacturer approved equipment to conduct tests.

Basis: NFPA 72-7-2.2 (Ref. 10.4). Compliance with this NFPA code is required per Appendix G of the UC contract.

7.0 RECOMMENDATIONS AND GOOD PRACTICES

The purpose of this section is to clearly state what the in-scope Criterion user should consider in the development of his O&M program. In this section concisely state what O&M related activities are recommended for the subject equipment/system. Recommended activities shall be driven by either:

- 1. **Industry standards and practices.** Review generally accepted industry standards and guidelines to identify best practices in operations and maintenance for the subject SSCs.*
- 2. **Industry codes and standards.** Review generally accepted industry codes to identify code recommendations for operations and maintenance for the subject SSCs.*
- 3. **Manufacturer's recommendations.** The primary guide to maintenance and operational requirements can be obtained from a manufacturer of the structure, system, or component. These Manufacturer recommendations should be used when the failure to perform the recommended actions could void the manufacturer's warranty or it is demonstrated that failure to perform the maintenance / operations actions could cause the SSC to fail to meet the requirement to be "available for intended use."*
- 4. **Operating experience, the DOE/LANL Lessons Learned program, and/or engineering judgement.** Operating experience, Lessons Learned, and engineering judgement should also be researched and applied for additional recommendations. As a minimum, Lessons-Learned reports should be researched back 5 years from the date that the Criterion is being developed. Lesson Learned data is available through the DOE Occurrence Reporting Program and its data system, the Occurrence Reporting and Processing Systems (ORPS) located at the following web address: <http://tis.eh.doe.gov/web/oeaf/orps/orps.html>. A copy of all ORPS reports research by the Criterion author shall be provided in the project file (to be maintained by the O&M Criterion Project Manager).*

In development of the Criterion, LIGs should be referred to but not restated. However, the recommendations shall be restated when taken from DOE Orders, codes, standards, Lessons-Learned information, LANL communications, etc. that are not readily available to the user. Where this is not possible, a summary or paraphrase of the recommendation shall be provided

A "basis" statement shall be provided after each recommendation listed. The basis statement shall clearly list the source document (including reference number, revision, section and/or page number) and if appropriate, the driver for the document. If the basis is the author's judgement, manufacturer recommendations, or operational experience, a justification shall be provided. In no case shall the phrase "engineering judgement" be used as a stand-alone basis, the author shall include (succinctly – less than one paragraph) a defensible justification describing why the subject recommendation has been made. Manufacturer recommendations form the basis for LANL recommendations when the failure to perform the recommended actions will void the manufacturers warranty or it is demonstrated that failure to perform the maintenance /

operations actions will cause the SSC to fail to meet the requirement to be “available for intended use.”

Section 7.1 shall be “Operations Recommendations” and Section 7.2 shall be “Maintenance Recommendations.” When there are no recommendations identified in a given subsection, simply state “No recommendations beyond those stated in Section 5.2, Limitations.”

In all cases, include the following statement immediately after the 7.0 Section heading:

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on his / her unique application and operating history of the subject systems / equipment.

Example

7.0 RECOMMENDATIONS AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on his / her unique application and operating history of the subject systems / equipment.

7.1 Operations Recommendations

7.1.1 Motors are designed to operate at or below any maximum surface temperature stated on the nameplate. Failure to operate the motor properly can cause this maximum surface temperature to be exceeded. If applied in a hazardous area, this excessive temperature may cause ignition of hazardous materials. Operating motors at any of the following conditions can cause nameplate temperatures to be exceeded:

- A. Motor load exceeding service factor value
- B. Ambient temperatures above nameplate value
- C. Voltages above or below nameplate value
- D. Unbalanced voltages
- E. Loss of proper ventilation
- F. Variable frequency operation
- G. Altitude above 3000 ft.
- H. Severe duty cycles – repeated starts
- I. Motor stalls, motor reversing, or single phase operation

Basis: Recommendations provided by DOE Motor Challenge Program (Ref. 10.5).

7.2 Maintenance Recommendations

Careful and regular maintenance and inspections are required to detect and clear any faults as early as possible before major damage can develop. Only general inspection intervals for trouble-free operation can be recommended because of the widely differing operating conditions. The inspection intervals shall therefore be matched to the prevailing circumstances (dirt, deposits, frequent starts, loading, temperature, etc.). Special information provided by motor manufactures must also be followed. The following Maintenance Recommended Frequency Matrix is provided as a general guide.

Table 7-1

Table 7-1 Recommendations Frequency Matrix			
Chart Legend I = Inspect, T = Test, M = Monitor, P = Perform			
	Qtr (3mo)	6 mo	1yr
COMPONENT - MOTOR			
<i>Monitor of Operating Conditions</i>			
Power			T
Power Factor			T
<i>Monitor Thermal, Vibration, Acoustics</i>			
Thermographic/Temperature Assessments			M
Vibration Monitoring			M
Acoustics			M
<i>Electrical Motors in Storage</i>			
Lubrication			P
Start/Run (when available)	P		
Shaft Rotations	P		

Basis: See basis statements in Sections 7.2.1 through 7.2.3.

7.2.1 Thermal, Vibration, and Acoustic Monitoring

Test electrical motors with high safety and risk levels on a routine basis for running temperature utilizing a contact thermometer at the middle of the motor housing and at the inboard and outboard bearing housings after the motor has come up to operating temperature and record. Thermograph scans are acceptable as well. Test the same electrical motors for excessive vibration and acoustical noise that may alert experienced personnel to problems. Reference the following guide for guidance in motor vibration.

Table 7-2

Table 7-2 Vibration Limits-Solo Run Test
Resiliently Mounted Machines

RPM @ 60 Hz	Velocity in/s peak	Velocity mm/s peak
3600	0.15	3.6
1800	0.15	3.6
1200	0.15	3.6
900	0.12	3
720	0.09	2.3
600	0.06	2
Note: For machines with rigid mounting, multiply the limiting values by 0.8. (Ref. NEMA Std. MG1-7.08.1 Table 7-1)		

Basis: Operations and maintenance field experience show monitoring of critical motors closely on a routine basis has proven to be an excellent tool to prevent unsafe and/or critical conditions, predict failure modes, and plan corrective actions prior to failure.

8.0 GUIDANCE

This section provides guidance on how to implement the requirements and recommendations delineated in Sections 6.0 and 7.0 above. The intent here is to provide guidance to the Criterion user for the development and implementation of his/her program and to prevent each FMU/user from re-inventing the wheel for acceptable program development and implementation.

Where possible, the guidance should track to the section numbers for each respective Requirement or Recommendation. For example, guidance on how to implement Requirement 6.2.3 should be provided in Section 8.2.3. Where no guidance is provided for a specific section or statement, simply state: "No implementing guidance available."

As a minimum (and if available), reference implementing LANL operations/maintenance procedures or job standard by number and title that have been (or will be) reviewed and approved by FWO-SEM that meet the expectations of the Criterion. (LIR 230-05-01, Section 5.0, states in part: "Verifying the Support Services Subcontractor procedures and programs comply with the Criteria for which they have lead responsibility." In the majority of cases, FWO-SEM has lead responsibility for these implementing procedures. For each reference to an existing LANL procedure, include the following pre-fix statement:

Provided it has been reviewed and approved by FWO-SEM...

Identify and discuss any preferred methods or techniques that should be used in implementing the requirements and recommendations. Where applicable, list additional technical reports, white papers, Lessons-Learned, EFCOG presentations, etc. that would be helpful to the user.

Example

8.1 Operations Guidance

- 8.1.1** Provided it has been reviewed and approved by FWO-SEM, an acceptable program for crane operator qualification may be found in MST procedure MST-123, "Crane Operator Qualification and Certification."

8.2 Maintenance Guidance

- 8.2.1** Provided it has been reviewed and approved by FWO-SEM, an acceptable program for motor circuit evaluation may be found in the JCNNM PMI 40-50-002 "Motor Circuit Evaluation." (Ref. 10.7 and 10.16)

- 8.2.2** A discussion of water chemistry issues unique to northern New Mexico and how to best develop and apply chemical addition is provided in Attachment A, "Water Chemistry Issues Unique to Northern New Mexico."

- 8.2.3** Appropriate selection and maintenance frequency criteria for motors should be based upon two main categories in the following priority:

- 8.2.3.1** *The graded approach* category, that is a selective assignment of resources to the maintenance of motors based on their level of risk. Motors are assigned to one of four categories based on the potential impact of a worst case failure on public safety, worker safety, the environment, safeguards and security, and the programmatic function. The categories are identified as ML1, ML2, ML3, and ML4, with ML1 representing the highest level of importance and the most rigorous level of maintenance and ML4 representing the lowest level of importance and requiring less frequent maintenance activities. (Ref. 10.3)

- 8.2.3.2** *The maintain or replace approach* category, that is a selective decision for each individual motor as to whether motor maintenance will be performed regularly or whether the motor will be allowed to operate until failure. The following factors to consider when making these selective decisions to maintain or replace are:

- A. Consequence and likelihood of failure
- B. Importance of having the motor back in service immediately
- C. Type and size of the motor (e.g., horsepower, efficiency rating)
- D. Application (speed/torque requirements), electrical operating costs and hours operated annually

- E. Simple payback analysis
- F. Cost and availability of repair service versus the cost of a new motor
- G. Age and repair history of the motor
- H. Maintenance and capital budgets

8.2.4 With further analyses and well-kept records, different types of lubricant, and/or optimized lubricant intervals improve a lubrication program. Improper greasing techniques shorten bearing and motor life. The thorough cleaning of grease relief ports, grease fittings, and grease gun nozzles prior to lubrication is necessary to allow for proper lubrication flow and for preventing introduction of contaminants. Maintaining cleanliness of lubricant and preventing introduction of contaminants into the lubricant is a very common problem. Utilizing cartridges rather than bulk lubricant can prevent some contamination problems. The free flow of grease is important to prevent damage to motor bearings. Grease guns are capable of producing high pressures that can literally drive seals and shields out of the bearing. Mixing of incompatible greases will cause bearing failures. Refer to Table 8-1. Adding too much grease or adding grease too frequently can force grease past bearing shields into the motor windings. Failure to remove purge plugs when lubricating bearing housings are equipped with such devices will cause excessive amounts of lubricant to be trapped in the bearing cavity and cause elevated operating temperatures and damaging high frequency vibration to occur.

Table 8-1

Table 8-1 Grease Compatability Chart										
	Aluminum Complex	Barium	Calcium	Calcium 12-hydroxy	Calcium Complex	Clay	Lithium	Lithium 12-hydroxy	Lithium Complex	Polyurea
Aluminum Complex	I	I	I	C	I	I	I	I	C	I
Barium	I	I	I	C	I	I	I	I	I	I
Calcium	I	I	I	C	I	C	C	B	C	I
Calcium 12-hydroxy	C	C	C	I	B	C	C	C	C	I
Calcium Complex	I	I	I	B	I	I	I	I	C	C
Clay	I	I	C	C	I	I	I	I	I	I
Lithium	I	I	C	C	I	I	I	C	C	I
Lithium 12-hydroxy	I	I	B	C	I	I	C	I	C	I
Lithium Complex	C	I	C	C	C	I	C	C	I	I
Polyurea	I	I	I	I	C	I	I	I	I	I
I=Incompatible C=Compatible B=Borderline										

- 8.2.5** Motor and load must be rigidly bound to a common structure or floor. Failure to maintain solid mountings will lead to misalignment induced vibration problems that may lead to bearing failure. Coupling alignment is important to coupling and bearing life. (Ref. 10.11)
- 8.2.6** Testing of operating speed should be performed utilizing a non-contact type tachometer for safety reasons. For belt-drive applications, it is important to measure the RPM of both the driver and the load to detect changes in slippage over time. Voltage and current checks may be performed utilizing the standard clamp-on ammeter and VOM. It is important to note phase balance because unbalance can dramatically reduce motor efficiency and life. Check both voltage and current balance. A current imbalance over 2% is cause for immediate action. Significant changes in voltage are not likely to be caused by the motor, but affect the way a motor performs. Figure 8-1 shows how various load performance parameters tend to change with a departure from nameplate voltage. Power and power factor may be determined utilizing power factor meter or power meter. Provided it has been reviewed and approved by FWO-SEM, the use of JCNNM PMI 40-50-002 "Motor Circuit Evaluation" is acceptable. (Ref. 10.7 and 10.16)

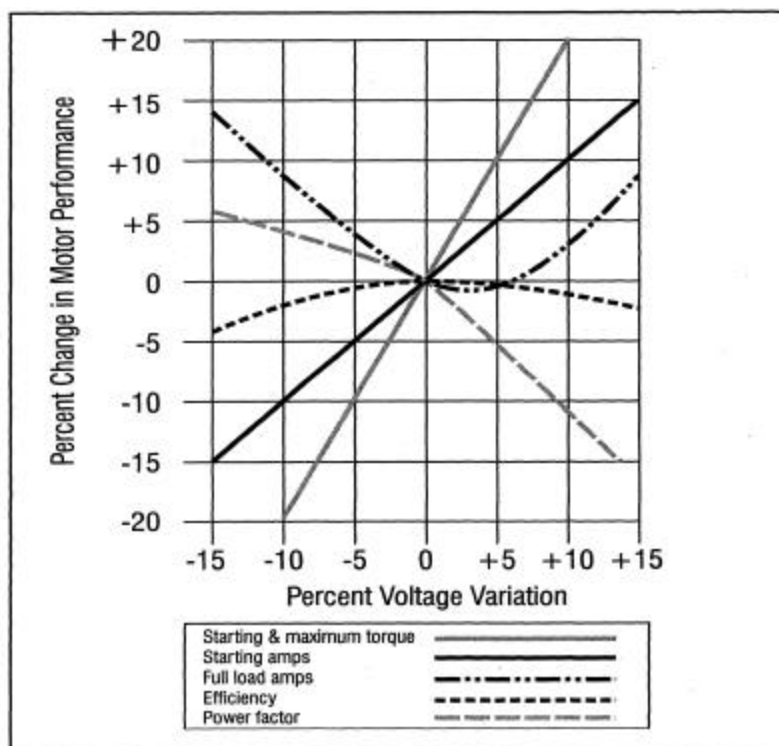


Figure 8-1, Effect of Voltage Variation on Induction Motor Performance Characteristics.

9.0 REQUIRED DOCUMENTATION

In this section, clearly define SSC-specific documentation that is required to comply with; LPRs, LIRs, Ars, Orders, codes, or standards committed to in the UC Contract; Formal commitments made to the DOE or other regulatory agencies or defensible Operating experience, the DOE/LANL Lessons Learned program, and/or defensible engineering judgement. The author shall provide samples of the required documentation as an Appendix to the subject criteria when specific formats are required.

Identify any required documentation of data, the types of required documentation, content, format necessary to maintain auditable records, and the basis for taking the data. If none is required, simply state "None required."

A "basis" statement shall be provided after each requirement listed. The basis statement shall clearly list the source document, where applicable (see LIR 230-05-01.0, Section 6.1 for other commitments), (including reference number, revision, section and/or page number) and if appropriate, the driver for the document. If the basis is the author's judgement, manufacturer requirements, or operational experience, a justification shall be provided. In no case shall the phrase "engineering judgement" be used as a stand-alone basis, the author shall include (succinctly – less than one paragraph, preferably in a sentence or two) a defensible justification describing why the subject requirement is necessary. Maintenance history shall be maintained for all maintenance activities performed on structures, systems or components addressed by this document as required by LPR 230-07-00 (Ref 10.7). The LPR Performance Criteria Number 2 states:

LPR 230-07-00, Performance Criteria # 2:

"Maintenance activities, equipment problems, and inspection and test results are documented."

The author shall list the documentation required for all requirements in Section 6.0, use the table established below.

In all cases, include the following statement immediately after the 9.0 Section heading:

Maintenance history shall be maintained for [criterion subject] to include, as a minimum, the parameters listed in the following table.

Example

9.1 REQUIRED DOCUMENTATION

Maintenance history shall be maintained for electric motors to include, as a minimum, the parameters listed in the following table:

Table 9-1 Documentation Parameters

MAINTENANCE HISTORY DOCUMENTATION PARAMETERS				
PARAMETER	ML 1	ML 2	ML 3	ML 4
Maintenance Activities				
Repair / Adjustments	X	X	X	X
Motor Replacement	X	X	X	X
Lubrication Evolutions	X	X	X	
Equipment Problems				
Failure Dates	X	X	X	
Failure Root Cause	X	X	X	
Inspection Results				
Inboard Bearing Temperature	X	X		
Outboard Bearing Temperature	X	X		
Vibration Analysis Data	X	X		
Leg Voltage	X			
Start-Up Current per Leg	X			

Basis: Documentation of the parameters listed in Table 9-1 above satisfies the requirements of LPR 230-07-00, Criteria 2, which states; "Maintenance activities, equipment problems, and inspection and test results are documented."

10.0 REFERENCES

In this section, list all documents that are directly noted in the body of the Criterion. Do not include a blanket listing of additional references that were not directly referenced in the body of the Criterion. Include dates and/or revision numbers in references.

Example

10.0 REFERENCES

- 10.1 LIR 230-05-01.0, Operation and Maintenance Manual.
- 10.2 DOE O 430.1A, Attachment 2 "Contractor Requirements Document" (Paragraph 2, Sections A through C), a requirement of Appendix G of the UC Contract.
- 10.3 DOE Order 4330.4B, Maintenance Management Program, Section 3.4.9.
- 10.4 LIR 301-00-02.0, Variances and Exceptions to Laboratory Operation Requirements.

- 10.5** LIR 230-014-01.0, Laboratory Maintenance Management Program.
- 10.6** JCNNM PMI 41-50-002, "Motor Circuit Evaluation."
- 10.7** OSHA 1910.212, Occupational Safety & Health Administration "General Requirements for all machines," subpart title, "Machinery and Machine Guarding."
- 10.8** LPR 230-07-00.0, Maintenance History, Performance Criteria [2].

11.0 APPENDICES

In this section list additional appendices that are referenced in the body of the Criterion. Appendices may be used to include such items as recommended data sheet formats/forms, special instructions, excerpts of requirements/codes/laws, recommended maintenance program, or any other supplemental information, which will aid in the implementation of the Criterion.

Example**APPENDIX A****RELIANCE PROPER MOTOR LUBRICATION WHITE PAPER – B-5021****White Paper:****AC Motors****Proper Motor Lubrication**

|Open Bearing | Sealed Bearing | Shielded Bearing | Lubrication Techniques | Over-greasing |

The service life of most motors is dependent on a little bit of good grease at the right times. This report discusses the pros and cons of different types of bearings, under-or-over-lubrication problems, and proper lubrication techniques.

Most motor failures are related to bearing failures. However, most bearing failures are not the result of bearing fatigue but improper lubrication. Bearing fatigue life calculations are commonly referred to as L-10 life (previously B-10). These calculations, expressed in thousands of hours of bearing life, give a good indication if a specific bearing can handle a specific load; but they cannot and should not be used to predict bearing life. Why? Because it all comes back to taking care of that bearing with good lubrication practice.

Before we can discuss good lubrication practices we need to understand the basic types of bearings that motor manufacturers generally use, along with their advantages and disadvantages.

[Intermediate pages deleted for guide]